

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

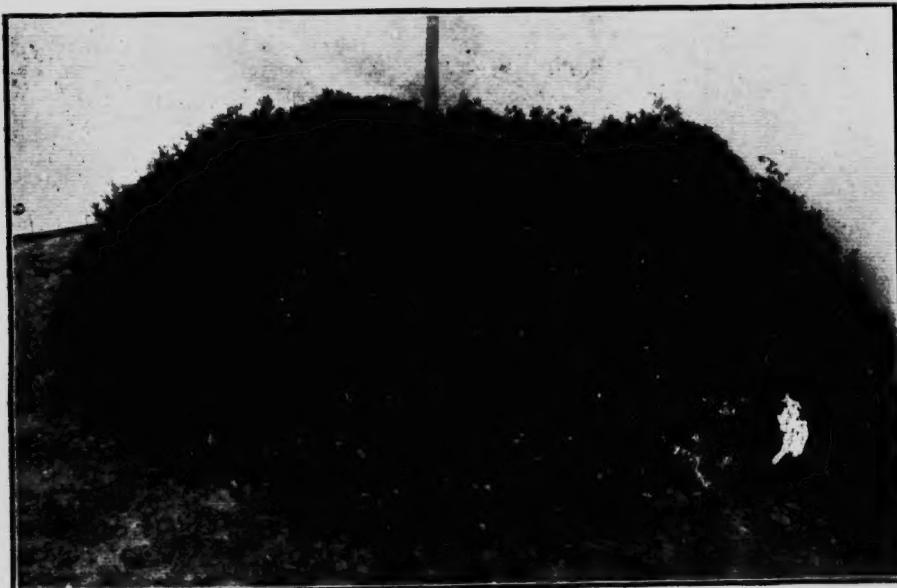
BULLETIN 280

Alfalfa

By

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A large plant of Alfalfa about seven feet in diameter and still spreading by means of creeping root stocks.

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READ THIS, AND THEN READ THE BULLETIN

Alfalfa has been grown experimentally at the O.A.C. since 1896.

The leading varieties, according to a ten-year test, including yield and hardiness, are Grimm and Ontario Variegated.

It is usually profitable, before sowing, to inoculate the seed with Nitro-culture.

The seed selected for sowing should be of an approved variety, free of weed seeds, and should test high in germination. The Seed Laboratory, Department of Agriculture, Ottawa, will test samples for purity and vitality.

Alfalfa may be sown—

(a) In July without a nurse crop, after fallowing.

(b) At the usual seeding time with a cereal nurse crop, barley or wheat, sown thinly.

(c) On winter wheat, preferably in the early spring, on fresh snow.

Alfalfa is good for the soil on which it grows, good for the animals that eat it, and therefore good for the pocket of the farmer who raises it.

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INTRODUCTION.

Alfalfa or Lucerne is a deep-rooted leguminous plant. It possesses a combination of characteristics which is not found in any other farm crop. The growth of alfalfa starts early in the spring and continues throughout the summer and even into the late autumn. Its large yields of nutritious feed for farm stock,



A group of farmers listening to a talk on Ontario Variegated Alfalfa, the flowers of which are variegated in color, being composed of violet, blue, green and yellow, and various blends of these with each other.

its perennial habit of growth and its beneficial influence on the soil are all features which commend it highly. Its power of making use of the free nitrogen of the atmosphere and of the fertilizing elements of the subsoil is of great value. Alfalfa produces two or three crops per annum in Ontario and, under favorable conditions, thrives for several years without the necessity of re-seeding. The feed is relished by practically all kinds of farm stock. It can be used in the green or in the dry condition, or it can be converted into silage. In some localities of the Province



Weighing grasses grown on the experimental plots.



An eleven-acre field of Ontario Variegated Alfalfa grown on the College farm.



Loading Alfalfa in a thirty-acre field on the College farm.



ALFALFA.
(Medicago sativa).

the second crop in the season is allowed to ripen for seed production to good advantage. Alfalfa is particularly suitable for use in a long rotation, and it leaves the soil in an excellent condition to be followed by other farm crops. In order to grow alfalfa successfully, however, it is necessary to understand the crop and to adopt the very best methods for its growth. Fortunate, indeed, is that country which can produce alfalfa satisfactorily as a regular farm crop.

Eight years ago the Ontario Bureau of Industries commenced to collect and to report data regarding the areas of alfalfa in Ontario. According to reports received in 1912, and in each of the years since then, there has been an average of 168,014 acres of alfalfa grown in this Province annually. The scarcity of seed of the right kinds of alfalfa is probably the greatest hindrance to a decided increase in alfalfa production in Ontario at the present time. Efforts are being made to encourage the more abundant growth of seed of the hardy alfalfas. In all but unfavorable years this seed can be grown very profitably.

EXPERIMENTS WITH ALFALFA.

Within the past twenty-eight years a large amount of experimental work has been conducted in the growing of alfalfa in the Department of Field Husbandry at the Ontario Agricultural College. The College farm is located inland about thirty miles from Lake Ontario, sixty miles from Lake Erie, and seventy miles from Lake Huron, and at an elevation of 740 feet above the level of Lake Ontario, and of 1,100 feet above sea level.

The total rainfall at Guelph for the six growing months, from April to September inclusive, was 17.2 inches in 1919, 21.9 inches in 1918, 25.3 inches in 1917, 17.2 inches in 1916, 22.7 inches in 1915, 15.1 inches in 1914, and 17.1 inches in the average of the past twenty years. The total rainfall in the whole Province for the six corresponding months was 16.2 inches in the average of the past thirty-seven years.

A portion of the experimental grounds at the College has a gentle slope towards the south, another portion towards the north, and a part of the land is comparatively level. The soil in the trial grounds in which most of the experiments with alfalfa were conducted is what might be termed an average clay loam. The bottom lands are tile drained and contain rather more vegetable matter than the higher portions which have a natural drainage. Hardy varieties of alfalfa have grown well on all parts of the field except on the low land, which will not permit of being underdrained to a greater depth than eighteen or twenty inches. On this low land, which has a wet soil, the alfalfa does not usually live for more than two seasons.

The plots of the different alfalfa experiments have varied in size according to the requirements of the tests, but the individual plots comprising any one test have been exactly alike in shape and in size and as nearly as possible in uniformity of soil. Each crop produced on every plot has been weighed in the field four times, once immediately on being cut and when green, and three times in the condition of cured hay. The yields per acre have been determined from the actual yields of the plots in all cases. It is scarcely necessary to state that great care has been exercised in connection with the details of each experiment.

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SIXTY-SIX CUTTINGS OF ALFALFA IN TWENTY-TWO YEARS.

In each of the past twenty-four years experiments have been conducted in growing alfalfa in the experimental grounds at Guelph. The results for 1899 and for 1905 were not recorded in sufficient detail to permit of their being reported. For the other years, however, accurate determinations were made. A number of different seedings are represented. Each seeding took place in the spring of the year by sowing from eighteen to twenty pounds of alfalfa seed per acre, which was usually sown in combination with a grain crop, such as barley, at the rate of one bushel per acre.

The following table gives yields per acre of different cuttings of green alfalfa and of cured hay produced in each of twenty-two years:

Year	Green Crop					Hay				
	First Cutting	Second Cutting	Third Cutting	Fourth Cutting	Total	First Cutting	Second Cutting	Third Cutting	Fourth Cutting	Total
1896	Tons 9.96	Tons 6.47	Tons 4.06	Tons 2.06	Tons 22.55	Tons 3.08	Tons 1.91	Tons 1.29	Tons .65	Tons 6.93
1897	12.04	5.61	4.42	.00	22.08	3.59	1.56	1.23	.00	6.38
1898	9.71	5.85	2.64	.00	18.20	2.30	1.75	.63	.00	4.68
1900	11.93	6.00	1.60	.00	19.53	2.33	1.47	.80	.00	4.60
1901	9.70	2.20	7.49	.00	19.39	2.03	1.00	1.50	.00	4.53
1902	13.35	8.69	2.96	.00	25.00	2.50	2.02	.54	.00	5.06
1903	13.10	8.53	2.75	.00	24.38	2.50	2.09	.67	.00	5.25
1904	12.45	9.35	4.00	.00	25.80	3.40	2.50	1.08	.00	6.98
1906	9.78	6.60	4.85	.00	21.23	2.55	1.13	.58	.00	4.26
1907	14.55	3.95	.00	.00	18.50	2.95	1.05	.00	.00	4.00
1908	9.70	6.75	3.73	.00	20.18	2.50	1.15	.75	.00	4.40
1909	8.68	4.56	.84	.00	14.08	2.52	1.40	.14	.00	4.06
1910	15.08	3.88	4.76	.00	23.72	2.94	.80	1.32	.00	5.06
1911	8.00	1.80	1.36	.00	11.16	1.76	.34	.30	.00	2.40
1912	9.48	4.68	4.72	.00	18.88	2.08	.99	.56	.00	3.63
1913	9.00	2.96	2.33	.00	14.29	2.66	.98	.68	.00	4.22
1914	7.64	1.61	4.28	.00	18.53	2.32	.51	1.02	.00	3.88
1915	10.63	6.06	6.92	.00	23.61	3.07	.31	1.53	.00	5.91
1916	13.29	6.86	2.40	.00	22.55	3.10	.31	.83	.00	5.53
1917	12.04	5.54	2.60	.00	20.18	2.49	1.00	.90	.00	4.80
1918	2.38	1.98	2.00	.00	6.36	.64	.60	.66	.00	1.90
1919	5.20	1.84	2.12	.00	9.16	1.60	.64	.92	.00	3.16
Ave. 22	10.35	5.08	3.31	.07	18.83	2.49	1.28	.82	.03	4.62
Yrs.										

The average dates of cutting for the twenty-two years were June 23rd for the first, July 30th for the second, and September 17th for the third.

In each of twenty years the alfalfa gave three cuttings per annum, in 1907 two cuttings, and in 1896 four cuttings were produced in the one season. The spring of 1896 opened up very early and that of 1907 very late.

The yield of alfalfa hay per acre amounted to over six tons in each of three years, between five and six tons in each of five years, between four and five tons in each of nine years, and less than four tons in each of five years.

The results show that on the average the first crop of the season was about double the yield of the second, and that the second was about one and one-half times that of the third. In some years the yields of alfalfa per acre were two or three times as large as those of other years. The average annual production

of alfalfa for the twenty-two year period was about nineteen tons of green crop and fully four and one-half tons of hay per acre.

The green alfalfa furnished on an average 24.6 per cent. of its weight of dried hay.

ALFALFA AND ITS DIFFERENT SPECIES.

Alfalfa is frequently called lucerne, and botanically belongs to the leguminosæ family of plants. It is not a clover, but both are legumes. The scientific name of the common alfalfa is *Medicago sativa* and that of the common red clover *Trifolium pratense*.

Alfalfa is said to have been a native of Western Asia and its cultivation by Greeks and Romans goes back for upwards of two thousand years. It has been extensively grown in the regions of the Mediterranean Sea, and its cultivation has been extended to many of the other parts of the world. At the time of the Spanish invasion the common alfalfa was introduced into Mexico, and in 1854



Alfalfa plants of an upright growth at the right, and of a spreading habit of growth at the left.

into California. It is now grown very extensively in the Central-western States.

The number of species of alfalfa which have been brought into cultivation are indeed limited. Four different species have been under test in our trial grounds in each of the past eleven years. A brief description of each of these species is here presented.

Common or violet alfalfa (*Medicago sativa*) is the species which has been grown extensively for centuries in some of the comparatively warm countries of the world. It is this type of alfalfa which is grown almost entirely in Central America, and in Mexico and also in Texas, California, Utah, Colorado, Nebraska and Kansas, and in other southern and central States of the American Union. The plants of the common alfalfa have an upright growth and numerous stems which grow from the crowns of the roots. The flowers are violet in color, the coloring matter appearing in different degrees of density, extending from a comparatively deep to a very pale violet, the latter being almost white. The seed pods are coiled in two or three spirals, the seeds are kidney-shaped, and are about one-twelfth inch in length.

Variegated alfalfa (*Medicago media*) is supposed to be a natural cross between the *Medicago sativa* and the *Medicago falcata*. The plants are mostly upright,

but some have a spreading habit of growth. The flowers are variegated in color, and besides the violet, include shades of blue, green and yellow, and various blends of these with each other, and with violet. The seed of the variegated closely resembles that of the common alfalfa.

Yellow lucerne (*Medicago falcata*) grows wild in some of the European and the Asiatic countries, and is considered to be very hardy. It generally has a spreading habit of growth, the stems being somewhat slender, and the leaves rather narrow. The flowers are yellow in color, the seed pods are sickle-shaped, and the seeds are somewhat smaller than those of the common alfalfa.

Hairy Stemmed Yellow lucerne (*Medicago ruthenica*) has a spreading habit of growth, and yellow flowers with seed pods which are flat and somewhat oval. The seed is brownish in color, distinctly lobed, and is considerably larger than that of the common alfalfa.

The following table gives the average yield of hay per acre for 1919 and for the ten year period. Of the different species there were three plots of the first, two plots of both the second and the third and only one plot of the last. All of the ten years' crops came from the seedlings which took place in the spring of 1909:

Species	Source of Seed	Yield of Hay per Acre	
		1919	Average 10 years
		Tons	Tons
Violet or Common Alfalfa..... <i>(Medicago sativa)</i>	United States (Colorado, Utah and Nebraska)	.02	1.01
Variegated Alfalfa..... <i>(Medicago media)</i>	Ontario (Welland and Lincoln Counties)	1.25	3.20
Yellow Lucerne..... <i>(Medicago falcata)</i>	Russia	2.27	2.24
Hairy Stemmed Yellow Lucerne..... <i>(Medicago ruthenica)</i>	Russia	.00	.10

The tabulated results show that the Common alfalfas are comparatively low, and those for 1919 indicate that only a few of the plants are now alive. The seed was obtained from Colorado and from Utah, two of the great alfalfa seed producing States of the American Union. If the history of this seed traces back to California, Mexico, Central America and Spain it will be seen that this particular alfalfa has been grown in warm climates for hundreds of years. Various other tests also show us that seed of this character produces plants which lack hardiness when grown in Ontario.

The average results of the Variegated alfalfa surpassed each of the other three species in yield of hay per acre in the average of ten years. The two lots of the Ontario Variegated alfalfa in this test belong to the strain which has been grown in the Province since 1871. It seems apparent that at least some of the plants of the Variegated alfalfa inherited hardiness from the *falcata* parent. Within the past forty-eight years, during the period of growth of this particular kind of alfalfa in Ontario, it is quite probable that the tender plants have been eliminated and that the more hardy ones have survived by natural selection.

The Yellow lucerne shows a fairly good yield, which is due to the hardiness of the plants more than to the vigor of growth.

The Hairy Stemmed Yellow lucerne gave very low yields throughout owing to the comparatively small growth of the individual plants rather than to the lack

of hardness. This species appears to have no particular value as a farm crop but may prove of service for the plant breeder.

VARIETIES OF ALFALFA.

Alfalfas have obtained their varietal names from the countries in which they have been grown for a length of time, from the men who have been instrumental in their introduction or in their improvement, from the color of their flowers, etc. There are many of these so-called varieties of alfalfa. While some of these different kinds do not vary from each other to any great extent from a botanical standpoint, there are some marked variations in character of growth, in hardiness, and in productiveness. Information along these lines is of great importance in connection with alfalfa production in Ontario.

A TEN YEARS' TEST OF TEN VARIETIES OF ALFALFA.

An experiment was started at the College in the spring of 1909 in which a number of varieties of alfalfa were sown at the rate of twenty pounds of seed per acre, with barley as a nurse crop. This experiment included some of the most noted varieties of alfalfa which were known in Canada and in the United States, and also others which were not so well known, except in an experimental way. As there were ten lots of Sand lucerne from Europe, four lots of Common alfalfa from the central-western States, three lots of Grimm alfalfa from Minnesota and Nebraska, and two lots each of the Variegated alfalfa from Ontario, and of the Turkestan alfalfa from Asia, the results from these different lots of the separate varieties were averaged, and these averages, as well as the results of other varieties taken separately, are presented for each of the past ten years. It is important to note that in the autumn of the first season of this experiment there was from 85 to 95 per cent. of a perfect stand of plants on each plot. The results have been affected principally by the comparative hardiness of the different varieties, and from this standpoint are particularly interesting.

It should be clearly understood that all the crops reported in the table here presented were produced from the one seeding, which took place in the spring of 1909.

It will be observed that the yields of alfalfa vary greatly from year to year, even from the one seeding. These differences are largely due to seasonal conditions. It will be noticed, for instance, that practically all varieties produced larger yields of hay in 1912 than in 1911, in 1915 than in 1914, and in 1919 than in 1918. The results indicate the large amount of winter killing which took place in the winter of 1917-18, the weather conditions of which were unusually severe.

Of the ten varieties of alfalfa here reported five had variegated and five violet flowers. With only one exception the variegated surpassed the violet flowered varieties in productiveness.

In addition to the testing of one or more lots of each of the ten varieties of alfalfa, in plots of equal size, another test was made with exactly the same kinds of alfalfa, by planting the seed of each lot in two rows and leaving the plants at equal distances apart in the rows. This test has also been continued for a period of ten years, definite information being taken annually regarding the individual plants.

The following table gives the results of the percentage variegated, the comparative growth of the plants early in the spring and the percentage of living plants in each of the past eleven years, including 1909, the spring in which the seed was planted:

Varieties	Per Cent. Variegated Flowers (6 years)	Comparative Early Spring Growth (7 years)	Per Cent. of Living Plants										
			1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Grimm.....	34	96	100	100	97	91	77	68	66	57	53	26	25
Ontario Variegated..	19	94	100	100	96	96	82	82	79	68	43	17	16
Baltic.....	36	91	100	100	89	86	81	72	69	56	44	11	11
European Vari g'ated	29	93	100	100	76	71	52	42	39	28	22	4	4
Mongolian.....	3	48	100	100	100	100	97	92	92	92	92	64	64
Turkestan.....	1	84	100	96	81	63	43	39	36	33	30	10	10
Sand.....	29	100	100	100	88	87	56	42	40	27	24	3	3
Common.....	1	64	100	99	79	62	26	22	20	8	6	0	0
Peruvian.....	0	51	100	94	8	0	0	0	0	0	0	0	0
Arabian.....	0	—	100	8	0	0	0	0	0	0	0	0	0

The foregoing table shows that each of the Variegated alfalfas made a more rapid growth in the spring of the year than any of the violet flowered varieties. The slowest growth was made by the Mongolian. It will be seen that the Common, the Turkestan and the Mongolian varieties had a slight percentage of variegated flowers as an impurity.

In regard to the percentage of living plants, it is interesting to note that up to the end of the eighth year the Ontario Variegated had a larger percentage than any other variety, with the exception of the Mongolian. In the last year of the test, however, the three varieties which still retained the greatest percentage of living plants were the Mongolian, the Grimm and the Ontario Variegated. There were no living plants of the Arabian after the second, the Peruvian after the third, and the Common after the ninth year. Although the Mongolian proved to be the hardiest of all the varieties under test, it will be seen by the former table that it occupied fifth place in average yield of hay per acre. The two varieties

which made comparatively high results in both yield of hay per acre and in percentage of living plants, were the Grimm and the Ontario Variegated.

The Grimm alfalfa, which gave the largest average yield of hay per acre, is becoming favorably known in Canada and in the Northern States. This variety has an interesting history. It received its name from Kulsheim Grimm, who brought alfalfa seed with him when he moved from Baden, Germany, to the State of Minnesota where he sowed the seed on his farm in the spring of 1858. The Grimm alfalfa is still raised in the neighborhood of Grimm's old home in Carver County, Minnesota. It was evidently an important strain of Variegated alfalfa which Mr. Grimm brought from Germany, and through the natural selection of the past sixty-one years many of the tender plants have been destroyed and only the hardy ones have withstood the severe winters of Minnesota. In the autumn of 1913 it was the privilege of the writer to visit the States of Wisconsin, Minnesota, South Dakota, North Dakota, Montana, Washington and Idaho, and to study at first hand the value of the Grimm alfalfa in these Northern States. It is making a uniformly good record throughout, and the demand for seed is much greater than the supply which is as yet only produced in a limited quantity.

Ontario Variegated alfalfa, which comes second in yield of hay per acre, also has an interesting history, which the writer has recently been able to trace. In the year of 1871, Nathaniel Bethel, a farmer and stock-man living in Welland County, Ontario, went to New York to purchase an imported sheep. When there he secured from the shepherd, who brought the sheep across the ocean, two pounds of alfalfa seed which came from Lorraine, a tract of country which was transferred from France to Germany in the same year. Mr. Bethel sowed the alfalfa seed on a gentle slope of a clay field on his farm in the spring of 1872. The alfalfa area was increased from home grown seed, and, in 1877, Mr. Bethel raised and sold about seventy bushels of seed produced on less than ten acres. He sent a sample of the seed to the International Exhibition in Paris, for which a diploma was awarded. This strain of alfalfa has given excellent satisfaction and has spread in several counties, particularly Lincoln, Welland and Haldimand. The Ontario Variegated is still grown on the same farm in which it was sown forty-eight years ago. There are several farmers in the vicinity of Mr. Bethel's old home who have never grown any other variety except this Variegated alfalfa.

Dr. Colver, who was both a physician and a farmer, and who lived in Lincoln County, Ontario, imported fifty pounds of alfalfa seed from Baden, Germany, in 1875. Dr. Colver sowed twenty pounds of this seed on his own farm and divided the rest of the seed amongst neighboring farmers. It is quite probable that at least a part of the Variegated alfalfa which is now grown in the vicinity of Wellandport and Silverdale, Lincoln County, Ontario, traces back to the seed introduced by Dr. Colver.

In the summer of 1912 we carefully examined the alfalfa fields on about one hundred and fifty Ontario farms, at the time when the blossoms could be seen to the best advantage. Nearly all of the fields examined in Welland and Lincoln Counties and some of those examined in Haldimand County were highly variegated. In some of the other counties, however, where the seed had been purchased from seed merchants, 98 to 100 per cent. of the flowers were violet, and scarcely a trace of the Variegated alfalfa could be found. This is undoubtedly one of the greatest reasons why there are so many failures in alfalfa growing in many parts of Ontario and why such a large number of old fields of alfalfa are to be found in Welland, Lincoln and Haldimand Counties which have been cropping continuously from the time they were sown twelve, fifteen, eighteen, and in some instances even more than

twenty years ago. It will be seen from what has been said that it is not surprising that the Ontario Variegated alfalfa, at the present time, is one of the hardiest and the most suitable varieties for use in this Province.

The Baltic variety of alfalfa was found growing at Baltic, South Dakota, from which place it received its name. On investigation this alfalfa was found to have a history very similar to that of the Grimm variety. It is now believed that the Baltic and the Grimm originated from the same source.

The European variegated alfalfas were obtained from different parts of France, Germany and Roumania and included such kinds as Old Frankish, Provence, Pfalzer and German Blue. The highest yielder of this group has been the Alt-deutsche Frankische, which is supposed to be the progenitor of our hardy Grimm alfalfa, which originally came from Baden, Germany.

The Mongolian alfalfa was obtained from Mongolia in the north-east of Asia through the kindness of the United States Department of Agriculture. Although this is not a variegated variety, it has given larger yields per acre than any of the other violet flowered varieties. It will be observed that it withstood better than any other variety the severe winter of 1917-18. In the ninth and tenth year, after seeding, it produced a higher yield of hay than any other variety of alfalfa under experiment. It is peculiar in its habit of growth, being one of the slowest to start in the spring, and in its recovery after the first crop of the season is harvested.

The Turkestan alfalfa came second in yield of the violet flowered varieties. It is known that the seed of these particular lots of Turkestan alfalfa came from Turkestan, in Asia. According to other experiments which we have conducted, it appears to be rather difficult to buy true Turkestan alfalfa seed commercially in this country.

The seed of the Sand lucernes included in this test came from France, Germany and the United States. The special strain of Sand lucerne which made the most satisfactory returns was obtained from the United States Department of Agriculture under the number 21269 and was originally obtained from Germany. The true Sand lucerne has highly variegated blossoms. Unfortunately, however, the seed of this variety seems to be quite unreliable when purchased in America.

All Common alfalfas, the seed of which was obtained in Canada and in the United States, gave comparatively low results. It is interesting to note, however, that of the seven lots of Common alfalfa the source of seed seemed to exert a marked influence in the productiveness of the crops. The Common alfalfa seed which was obtained from Chinook, Mont., was considered by the United States Department of Agriculture to be the hardiest of the Common alfalfas grown in the United States. The results show, however, that in average yield per acre the Common alfalfa of Montana was surpassed by the Common alfalfa of Ontario by one-eighth ton and by the Ontario Variegated alfalfa by one and one-half tons.

The Peruvian alfalfa, obtained from Peru in South America, is ~~com~~ ^{very} unsuited for cultivation in Ontario. In the southern and south-western states, however, it has done exceptionally well, outyielding practically all of the other commercial varieties of alfalfa.

The Arabian alfalfa, obtained from Southern Asia, is the most tender variety which we have ever grown at the College. Its use has not become general even in the southern states.

OTHER EXPERIMENTS WITH VARIETIES OF ALFALFA.

In the spring of 1905, an experiment with thirty-three varieties and strains of alfalfa was started. The experiment was conducted in duplicate. The more tender varieties were winter killed in a comparatively short time. Six of the plots, however, were cropped in 1919 for the fourteenth year. This experiment did not include such varieties as the Grimm, the Ontario Variegated and the Sand, which were scarcely known at the time the experiment was started. The highest average yields of hay per acre per annum were produced by three Turkestan alfalfas, the highest yielder, (3.0 tons) coming from Khiva, located in Turkey in Asia, the second highest, (2.8 tons) from Samarkand, in Russian Turkestan, and the third highest, (2.6 tons) from Sairam, located in Chinese Turkestan. These lots of alfalfa were obtained directly from these countries through the United States Department of Agriculture at Washington.



Plots of Hardy Alfalfas, including Grimm, Ontario Variegated and Sand Varieties sown with a nurse crop of barley in the spring of 1912, and from which 21 crops were removed previous to the autumn of 1919.

In 1909, an experiment, consisting of twelve plots conducted in duplicate and including different strains of hardy varieties, such as Grimm, Turkestan and Sand, was started. This experiment was continued for four years. In the average results of the eight separate tests conducted in the four-year period it was found that in yield of hay per acre per annum the Grimm alfalfa from Minnesota came first with 5.3 tons and the Sand lucerne B.P.I. No. 21269, second, with 4.9 tons.

In the spring of 1911, another experiment was started and continued until 1918 in which Grimm and Sand alfalfas were compared with a common violet variety. The average results for the whole period show the following average yields of hay per acre per annum: Grimm, from Minnesota 4.3 tons, Sand B.P.I. No. 21269, 4.1 tons and Common violet alfalfa 1.4 tons. In the first year of the experiment the Grimm alfalfa gave 5.3 tons and the Common alfalfa 4.1 tons, and in the last year of the experiment the Grimm alfalfa gave 2.9 tons and the Common

alfalfa .03 tons of hay per acre. This is another evidence of the hardiness of the Grimm alfalfa.

In the spring of 1912 still another experiment was started to which three varieties of hardy alfalfa were sown seven times in order that a very thorough test might be made regarding the comparative values of the varieties under test. This experiment has been continued to the present time. Each plot was cropped three times each year. In the seven-year period, therefore, twenty-one crops were removed from each plot of the seven separate tests. The following table gives the average annual yield of hay per acre of the seven tests conducted for the seven-year period with each of the three varieties:

Years	Sand (B.P.I. No. 21269, Germany)	Ontario Variegated (Welland County, Ontario)	Grimm (Excelsior, Minn., U.S.A.)
	Tons	Tons	Tons
1913	3.52	3.84	3.43
1914	3.30	3.42	3.38
1915	5.31	5.45	5.26
1916	4.14	4.92	4.83
1917	3.00	3.35	3.50
1918	1.70	1.36	2.55
1919	1.89	1.85	2.82
Average 7 years..	3.27	3.46	3.68

The foregoing results, from the three varieties of alfalfa which were outstanding for hardiness in former experiments, are interesting as they combine the results of seven separate tests in each of the seven years. Although the Ontario Variegated gave the highest results in the first year the Grimm alfalfa made the greatest returns in 1919, and in the average for the whole period. It will therefore be seen that of the various tests made with different varieties of alfalfa the three which have made the best all-round record for hay production, when hardiness and yield are both taken into consideration, are the Grimm, the Ontario Variegated and the Sand (B.P.I. No. 21269), and in the order here given.

ALFALFA PLANT BREEDING.

The careful testing of existing varieties and strains of alfalfa is important in securing the most suitable kinds for growing on the farms of Ontario. It is also of great value in ascertaining foundation material for breeding purposes. In order to do the very best work in plant breeding it is very desirable to have the most accurate information possible regarding the material already available. Even the best of existing varieties possess weaknesses. To improve the best kinds by selection, and when necessary by cross-fertilization, is the work of the plant breeder. Alfalfa, owing to its great variations in plant structure, forms a prolific field for investigation, with opportunities for achievements which are of both practical and scientific value.

Considerable work has been done at the Ontario Agricultural College with the object of securing hardy alfalfas suitable for hay or for pasture and which are at the same time good producers of seed. With this object in view many strains of



A small section of the Alfalfa Plant Breeding Grounds.



The examination of plants in the Alfalfa Plant Breeding Section.



Alfalfa plots showing results from Common Alfalfa seed from the Central Western States in the foreground, and of the Ontario Variegated Alfalfa in the background. It will be observed that the Common alfalfa is nearly all winter killed.



An interesting Alfalfa plant, showing method of reproduction by means of creeping root stalks. This was the original plant discovered at the Ontario Agricultural College after a careful study of thousands of plants produced from seed obtained from different parts of the world.



An Alfalfa plant with creeping root stalks removed from one of the plots at the College in the spring of 1920.

alfalfa have been tested in plots and thousands of alfalfa plants have been studied individually. We are obtaining hardy strains which we believe will be of real service to the farmers of the Province.

A nursery plot of one acre, with plants of the Grimm, the Baltic and the Ontario Variegated alfalfas was established in 1913. These plants have been grown at equal distances apart in order to give them the same opportunities for development. Some of the most tender plants have disappeared. The remaining plants are being carefully studied each year and seed is being secured from the most promising specimens. The object is to obtain foundation material from the most desirable plants of these hardy varieties now in cultivation.

A little packet of less than one hundred seeds of alfalfa, which came originally from Northern Norway, has furnished some interesting material. The plants are very hardy, the flowers variegated, but the yield of seed is not abundant. These plants resist our severe winters better than even those of the Grimm variety. We now have hundreds of plants of this strain, and seed is being secured from those plants which are making the highest record.

According to our present knowledge the Ontario Agricultural College was either the first or the second institution on the American Continent to discover an alfalfa plant which would spread by means of creeping root stalks or rhizomes. We now have some very interesting plants which spread abundantly from the underground stems. These plants, however, are very light producers of seed, but it is hoped by cross-fertilization to increase their seed producing powers.

A considerable amount of work has been done to prevent natural cross-fertilization by enclosing the plants in cages and by tripping the plants artificially. Crosses have been made between different species, varieties and strains of alfalfa and attempts have been made at the hybridization of alfalfa and sweet clover, and also of alfalfa and black meddick. Mr. William Southworth, when engaged in this Department, made a number of cross-pollinations between the alfalfa and the black meddick with the object of securing plants which would naturally pollinate more readily than does the alfalfa. It was thought that this cross was successful, but in studying the progeny in its different generations there seems to be no apparent evidence that a cross between these two types of plants took place.

As a result of our plant breeding work it is believed that in the near future we will have new varieties of alfalfa for Ontario which will surpass in various ways those kinds which are now used in cultivation.

ALFALFA SEED INOCULATION.

That leguminous crops such as alfalfa, sweet clover, sainfoin, red clover, vetches, peas and beans thrive best when they are grown in the presence of legume bacteria is now a well established fact. These micro-organisms, when present in well drained fertile soil, enter the roots of the plants forming enlargements or nodules on the root. These very minute forms of life make use of the free nitrogen of the atmosphere which is thus transferred to the plants making them more valuable in food constituents and in fertilizing materials. None of the other plants except the legumes can make use of the atmospheric nitrogen in this way. Each class of seed requires a different kind of culture. It is possible for alfalfa to grow fairly well without the presence of these minute forms of life by making use of the nitrogen already in the soil. Their presence, however, seems to have the

double value of increasing both the quality and the quantity of the crop. Whether or not the proper bacterial forms are in the soil can be ascertained by growing a small amount of alfalfa and examining the roots for the presence or absence of the nodules. If no nodules are present, it is quite evident that the soil is lacking the proper organisms. These, however, can be conveyed to the soil either by the application of inoculated soil from other fields or by the artificial inoculation of the seed. Extensive experimental work has shown that the easiest and best way is to inoculate the seed with the necessary bacteria. For fuller information, the reader is referred to Ontario Agricultural College Bulletin No. 164.

In 1897 experiments in the inoculation of seeds of leguminous crops were conducted at our College with nitro-cultures imported from Germany. At a later date, other experiments were conducted with bacterial preparations obtained from Washington and still later with those produced in the Bacteriological Department of our own College. We took great care in the experiments throughout and there was no marked advantage in the yields of the crops from the use of the different cultures. This was evidently due to the fact that the soil in the experimental grounds was already well inoculated from the successful growing of alfalfa in years past. This was made quite evident from the abundance of tubercles on the plants each year. In one experiment, however, which was conducted in duplicate for the four years from 1909 to 1912 inclusive, about seven-eighths of the separate tests showed some increase from the nitro-culture.

The Bacteriological Department of the Ontario Agricultural College has prepared and distributed legume cultures to farmers throughout Canada each year since 1905. In each of the ten years blank forms were sent with the cultures, on which the farmers were requested to report the results of the seed inoculation as to whether it had increased the crops.

In the ten year period 27,750 cultures were sent out and the reports received showed that 80 per cent. alfalfa and 70 per cent. red clover gave increased returns following seed inoculation.

SOIL, SEED AND SEEDING.

For the best results with alfalfa it is important to select land that is in a good state of fertility, and that has a deep calcareous sub-soil with a proper amount of moisture to enable the young plants to get a proper start during the first year. It is also important to select land which is comparatively free from seeds and roots of weeds and of other troublesome plants so that the alfalfa will take full possession of the soil. Alfalfa does particularly well after a cultivated crop in which the land has been thoroughly cleaned. In all cases the soil should be well cultivated and a fine seed bed formed to enable quick and uniform germination of the seed after it is sown.

The quality of the seed is of vital importance. It should be large, uniform and bright, of good vitality and free from impurities, especially from seeds of weeds and of other plants which are troublesome in a field of alfalfa. It is wise to secure a sample before the required quantity of seed is purchased and this can be sent to the Seed Laboratory, Department of Agriculture, Ottawa, and a report secured regarding the purity and the germination of the seed or it can be tested at home. If the seeds are large and uniform, are free from seeds of Sweet Clover, Yellow Trefoil, etc. and will germinate when placed between sheets of moist

blotting paper or in a box of sand which is kept warm and moist, the larger bulk can then be ordered according to sample. The bulk lot, when received, should also be examined in order to be sure that it is the same as the sample.

A little care in this way may avoid a total or a partial failure of a crop and also may prevent the introduction on the farm of weeds, which are difficult to eradicate.

Experiments have been conducted at the College in sowing alfalfa in the autumn and in the spring both with and without a nurse crop. The nurse crop used in the autumn was winter wheat and that used in the spring was oats. As a result of two distinct experiments, each extending over a period of two years, it was found that the spring sowing gave the better results. The alfalfa which was sown in the spring alone gave an average in the second year of the test of 17.2 tons and that sown with oats an average of 16.0 tons of green crop per acre. The alfalfa sown in the autumn with winter wheat was a partial failure and that sown without any nurse crop was badly winter killed.

In another experiment spring wheat, barley and oats were used as nurse crops. Five plots were sown with each kind of grain thus making fifteen plots sown with grain and alfalfa seed. The average total yields of green alfalfa per acre for two years obtained from the plots on which the nurse crops had been sown were as follows: spring wheat 20.5 tons, barley 18.0 tons and oats 12.9 tons. In this experiment the spring wheat proved to be the best and the oats the poorest crop with which to sow alfalfa. The oat crop, especially if the seed is sown thickly, has a tendency to smother out the young and tender plants of alfalfa. All nurse crops used with alfalfa should be sown rather thinly.

In still another experiment alfalfa was sown alone and with one bushel of barley per acre in the spring of the year. The test was made in duplicate. In the average results of the six tests in three years it was found that the seeding with barley gave a slight increase over the alfalfa which was sown alone. It has been found that when alfalfa has been sown without a nurse crop higher returns have been obtained from seeding in July than in the early spring.

In each of the past ten years alfalfa has been sown on winter wheat in the early spring. The seed was sown on old snow, on fresh snow of one or two inches, and on frozen ground. The average results show that sowing alfalfa seed on a fresh snow of one or two inches gave excellent satisfaction, proving successful in every instance. The seedlings on the old snow and on the frozen ground gave fairly good success. When alfalfa seed is sown early in this way no harrowing or cultivation is necessary. Germination takes place early and the young plants get a start before the winter wheat makes a large growth. This method requires less labor and is more successful than when the alfalfa seed is sown and harrowed in at later dates.

Experiments have shown that alfalfa seed sown alone in July on a summer fallow has given excellent satisfaction. This gives an opportunity of killing weeds and weed seeds, of conserving moisture, of furnishing an excellent seed bed, of enabling the alfalfa plants to get a good start before winter and in preventing weeds from producing seed in the autumn.

It is usual to sow from eighteen to twenty pounds of alfalfa seed per acre providing it is not sown in combination with different varieties of grasses and clovers. If the crop is to be grown principally for seed production, however, the amount might be reduced to fifteen or even to twelve pounds per acre if sown broadcast. Experiments have been conducted both at the College and throughout Ontario in sowing alfalfa seed in rows thirty inches apart, using only three pounds

of seed per acre. This is an excellent plan when only a small quantity of seed of particularly high quality is obtainable. The rows permit of cultivation and when sown thinly are apt to produce a large amount of seed in favorable seasons. It is usually considered wise to secure seed from the first cutting in the season when the crop is cultivated in rows and from the second crop when sown broadcast.

In preparing the land to receive the alfalfa seed it is an excellent plan to cultivate the soil thoroughly and then to follow with a weeder or with both a harrow and a weeder immediately before the seed is sown. If a nurse crop of grain is to be used the seeder attachment should be placed in front of the tubes of the grain drill. The land should then be levelled either with a light harrow or with a weeder. In this way the alfalfa seed has the advantage of being located between the rows of grain and at a suitable depth in well prepared soil which has been worked in such a way as to give the seed the advantage of both the fertility and the moisture in the soil.

MANURES AND FERTILIZERS WITH ALFALFA.

The influence of manures and fertilizers depends so much on the mechanical condition and on the fertility of the soil, as well as on many other conditions, that it makes it a very difficult matter to conduct experiments at any one place, the results of which are equally applicable to all kinds of land. Some soils are comparatively fertile while others are deficient in some of the fertilizing elements. Some soils are acid and require lime, while in other instances the application of lime would show no special advantage. These varying conditions, and many others should be taken into consideration when studying the results of fertilizer experiments conducted with alfalfa at any one place.

In a representative part of the experimental grounds, four plots, each one-twentieth of an acre in size, were set aside to test the influence of farmyard manure on alfalfa. On two of the plots farmyard manure was applied at the rate of twenty tons (about twelve loads) per acre, and this was thoroughly mixed throughout the soil. The other plots were left unmanured and the alfalfa seed was sown on all four plots. The crops were harvested and the results carefully recorded in each of three years. The following figures give the average annual yields in tons of green crop and of hay per acre per annum, respectively, of the duplicate plots conducted over the three-year period: manured land, 22.4 and 5.8; and unmanured land, 20.7 and 5.3. These results show an annual difference of about $1\frac{3}{4}$ tons of green crop and of $\frac{1}{2}$ ton of hay per acre in favor of the land which had received the farmyard manure.

In another experiment farmyard manure at the rate of twenty tons, and hen manure at the rate of five tons per acre were applied as top dressings on alfalfa plots which had already produced seven cuttings of alfalfa. The manures were applied after the first cutting of alfalfa had been taken from the land in the early part of the summer. After the application of the manures was made two crops of alfalfa were harvested in the same year and three crops in each of the two years following. The average annual yields in tons of green crop per acre for each of the treatments in the three years' test were as follows: farmyard manure 20.3, hen manure 18.9, and no manure 18.2. The influence of the hen manure was quite marked at first but that of the farmyard manure was more lasting.

Two experiments with commercial fertilizers with alfalfa have been conducted at the College. One of these consisted of twenty plots which were fertilized in the same spring in which the alfalfa seed was sown and the other consisted of twelve plots which were fertilized as a top dressing on the alfalfa sod after the crop was well established. The first experiment consisted of four tests with five plots in each and the second experiment of two tests with six plots in each test. The fertilizer used in each test consisted of Muriate of Potash and Nitrate of Soda each sown at the rate of 160 pounds; of Superphosphate at the rate of 320 pounds; and a complete fertilizer at the rate of 213 pounds per acre. In each test in the second experiment Basic Slag or Thomas' Phosphate Powder was also used at the rate of 320 pounds per acre. One plot was left unfertilized in each of the tests of both experiments. After the fertilizers were applied the first experiment was conducted for two and the second for three years. The results of these experiments show that the phosphatic fertilizers gave the greatest yield of alfalfa per acre. Of the different fertilizers used, the Superphosphate gave the highest yield per acre in the first experiment, and the Basic Slag or Thomas' Phosphate powder the highest, and the Superphosphate the second highest in the other experiment. The greatest average annual yield of green alfalfa per acre was produced on the land which had received the Superphosphate at the time the seed was sown but this increase, over the crop produced on the unfertilized land, was only three-fifths of a ton per acre.

ALFALFA SEED PRODUCTION.

The last four or five years have been abnormally wet, the amount of rainfall for the growing seasons being approximately 30 per cent. above the average. Previous to this period alfalfa seed production was becoming quite an industry in some parts of Ontario. As both a crop of hay and a crop of seed can be produced in the same season, if weather conditions are favorable, many of the alfalfa growers have found seed production quite profitable. From answers to extensive enquiries made from farmers who had grown alfalfa seed in Ontario for at least five years some very valuable information was obtained. We learned that alfalfa seed had been produced with success in at least thirteen counties of Ontario. In all cases where seed was produced it was taken from the second crop, the first crop of the season being converted into hay. The yield of alfalfa seed per acre varied considerably, the highest being seven bushels, and the average a little over two bushels per acre. The farmers determined the particular time for cutting the crop for seed production by the color of the pods, most of them stating that the crop should be cut when the pods were brown; some preferred to leave the crop until the pods were almost black. The majority cut their seed crop with a mowing machine, a number having used a table attachment with the machine. About 20 per cent. used the reaper and about 12 per cent. used the self-binder. As a rule the crop was cured in the windrow by those who used the mowing



Alfalfa seed cluster.

machine and in the bunches by those who used the reaper or the mowing machine with the table attachment. Those who used the self-binder cured the crop in shocks. The threshing was done mostly with a clover huller and took place almost any time after the crop was harvested until mid-winter. When the threshing was done in the autumn dry weather was preferable, and when in the winter, cold frosty weather gave the best results. Nearly all farmers reported having obtained good quality of seed in most years. The seed was sold chiefly to neighboring farmers and to local dealers. The greatest difficulties reported in alfalfa seed production in Ontario were due to injuries caused by grasshoppers, wet weather, blighted plants, early frosts, and a few mentioned partial failures from thick seeding. The ideal condition appeared to be a comparatively moist season for the production of the hay crop and a rather dry season after the hay had been removed from the land. The great majority stated that they considered seed production



One acre of Grimm Alfalfa sown in rows thirty inches apart by using three pounds of seed per acre. This photograph was taken in the autumn after the seed crop had been cut and shocked as shown.

did not injure the plants. Nearly all were enthusiastic in regard to the importance of alfalfa growing in Ontario, both from the standpoint of hay and of seed production.

CO-OPERATIVE EXPERIMENTS WITH ALFALFA.

Within the past few years a number of co-operative experiments have been arranged by the College and have been conducted by farmers in various parts of the Province. An experiment with different varieties was conducted through the medium of the Experimental Union, and all other experiments were arranged by the Field Husbandry Department of the College. All seed and instructions were sent out from the College either directly to the farmers who wished to conduct

the tests or through the Agricultural Representatives who had the tests conducted through the co-operation of some of the farmers of their respective counties. The various experiments included the following:

1. Testing different varieties of alfalfa.
2. Testing the influence of Lime with the alfalfa crop.
3. Testing the value of Inoculation with alfalfa seed.
4. Comparing alfalfa sown broadcast and in rows for seed production.
5. Comparing alfalfa in rows sown at the rate of one pound, two, three, four and six pounds per acre.
6. Comparing the first and second crop of alfalfa for seed production.

Some of the single plots were one acre in size, while in other instances they were smaller. The plots used for some of the row tests were one acre each. Those used for the lime and the inoculation tests were one-quarter acre and those used for the co-operative work, through the Experimental Union, were one-eightieth of an acre each in size.



An alfalfa field which has been cropping continuously for about fifteen years since it was sown. The crop shown is the third growth in the one season.

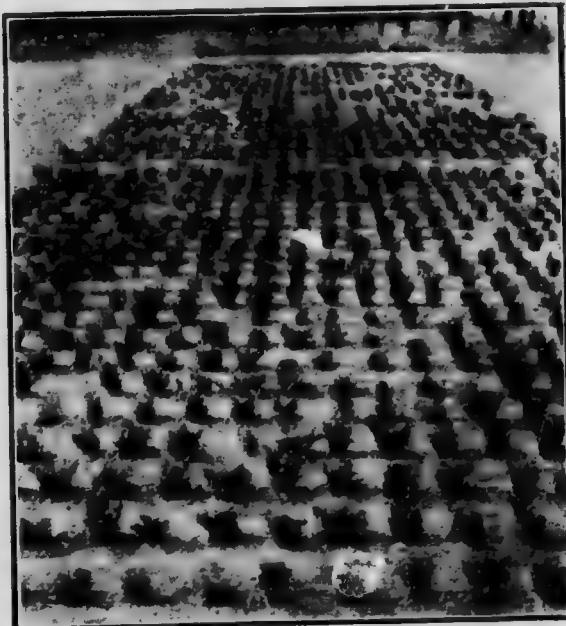
The variety tests up to date have covered a period of twelve years and all other co-operative experiments with alfalfa have been carried out principally within the past seven years, the chief experiments having been started in the years 1913, 1914 and 1915. The various co-operative experiments furnished valuable information in the different localities in which they were conducted, some of them having a marked influence in placing alfalfa production on a more permanent basis.

The various returns showed that the Grimm and the Ontario Variegated varieties proved more hardy than the Common, Southern or Northern grown alfalfa in the different counties. The reports along this line are very convincing.

In the co-operative tests the lime was applied at the rate of 1,600 pounds per acre in the form of ground unburned limestone, ground burned limestone, slaked lime or hydrated lime. The lime was thoroughly mixed through the soil before seeding took place. This material was supplied either by the Agricultural Representative or by the farmer himself. The results show decided variations from the influence of the lime. In some cases no advantage was observed from its appli-

cation while in other instances the increase in the alfalfa crop from the lime application was quite marked. One experimenter stated that his soil naturally contained a large amount of calcareous matter and that he saw no influence, whatever, from the limed as compared with the unlimed plot. On other soils, where lime was quite deficient, the application of lime showed a decided advantage. Of all the reports received, seventy-five per cent. of them showed applications of lime to be beneficial.

It is rather an interesting coincidence that the co-operative experiments conducted by the College in alfalfa seed inoculation gave exactly the same results as was obtained by the Bacteriological Department, the reports of which appear in another part of this bulletin. In both instances alfalfa seed which was inoculated gave higher results than the uninoculated seed in 80 per cent. of the individual tests.



A section of a nursery plot of young Alfalfa plants.

The results of the experiments in sowing alfalfa seed broadcast and in rows show a considerable variation. The broadcast system seemed to be preferable for hay production, but many reported favorably of the row system for the production of seed. Of the different amounts of seed, when sown in rows thirty inches apart, the results indicated the most favorable returns from three and four pounds per acre as compared with either thicker or thinner seeding. One of the special advantages of the row system is the fact that if only a small amount of alfalfa seed of some particularly hardy variety is available, it is a great advantage to sow this seed in rows at the rate of three or four pounds per acre in comparison with twelve to fifteen pounds per acre when sown broadcast, and when seed production is the main object in view. For seed production the general evidence favored using the first crop of the season when in rows and the second crop of the season when sown broadcast.

Owing to the very large amount of rainfall in the last few years alfalfa seed production has been abnormally low. In 1916 one acre of land was sown in the Experimental grounds at the College in rows thirty inches apart by using exactly three pounds of seed on the acre. The stand was almost perfect, the plants usually meeting between the rows. Similar evidence was obtained by a number of growers over Ontario, who sowed at the rate of from three to four pounds per acre in rows two and one-half feet apart. The seed produced from the first cutting at the College was 165 pounds per acre in 1919 and 74 pounds per acre in 1917. In 1918, owing to the exceptionally wet weather, the crop did not ripen and consequently produced hay instead of seed.

COMPOSITION OF ALFALFA, RED CLOVER AND TIMOTHY.

The Chemical Department at the College, in co-operation with the Field Husbandry Department, conducted experiments in each of two years in comparing the chemical composition and the digestibility of alfalfa, red clover, and timothy. Small portions were analyzed chemically to determine the composition and larger portions were fed to sheep to determine the digestibility. The following table gives the comparative amounts of digestible constituents in one ton of hay of each of three separate crops:

Constituents	Alfalfa	Red Clover	Timothy
	Lbs.	Lbs.	Lbs.
Protein	192.2	141.0	48.7
Fat	30.0	29.4	16.2
Nitrogen Free Extract.....	496.6	587.4	528.4
Fibre	206.5	209.4	306.9

The figures here presented are very suggestive and are worthy of study. They show that the alfalfa hay contained about fifty per cent. more digestible protein than hay made from common red clover, and about four times as much as that made from timothy.

INFLUENCE OF ALFALFA ROOTS ON THE SOIL.

Three separate experiments were conducted to ascertain the comparative value of the sods of alfalfa and of timothy. After the crops were removed from the plots the land containing the roots of these crops was plowed. On the sods of the first experiment, winter wheat was sown in the autumn of the year. On those of the second experiment, barley was sown in the following spring, and on those of the third experiment, corn was planted the next year. The average yields of the grain crops produced per acre are shown in the following table:

Sod	Winter Wheat	Barley	Corn
Alfalfa Sod.....	Bushels 61.5	Bushels 30.2	Bushels 24.0
Timothy Sod	42.1	19.7	17.9

In the second experiment the test with alfalfa and timothy sod was repeated four times. Barley was sown on each of the eight plots in the following spring. The detailed results of yields per acre were very interesting and are as follows:

Tests	Bushels of Barley per Acre	
	Alfalfa Sod	Timothy Sod
No. 1.....	27.9	13.4
No. 2.....	31.7	20.1
No. 3.....	31.0	19.6
No. 4	30.3	25.7

In comparing the mechanical condition of the soil on which alfalfa and different varieties of clovers and grasses had been grown, it was found that there was a decided variation, resulting from the action of the roots of the different crops on the soil. This influence was shown in two ways in particular; first, by the difficulty or the ease in which the sod land could be plowed, and second, by the stiffness or the mellow ness of the upturned sod. In one year twenty-eight plots of sod were plowed. These were made up of four separate tests each consisting of seven plots. Each test was made up of the sods of one variety of alfalfa and three varieties each of clover and of grass. When the plants of each of the four tests were plowed careful examinations were made and detailed notes were taken regarding the physical condition of the soil in each instance. It was found that the alfalfa sod was more difficult to plow than that of any of the clovers or the grasses, but that the inverted sod of the alfalfa plots was exceedingly mellow and friable, surpassing all others in this particular. The comparative differences of the various sods can be understood fairly well from the following figures:

Sods	Difficulty or ease in Plowing (10 being most difficult)	Loose, friable condition of inverted Sod (10 being most friable)
Alfalfa	10	10
Common Red Clover.....	5	7
Mammoth Clover	6	6
Alsike Clover.....	4	8
Timothy	8	3
Meadow Fescue.....	7	4
Orchard Grass	7	4

The alfalfa sod is usually somewhat more difficult to plow than that of the clovers or the grasses, owing to the very large roots of the alfalfa plants which are frequently pulled out of the subsoil instead of being broken or cut in two. Then the roots, to the length of two, three, four or five feet or even more, are dug out of the subsoil and left in the upper soil a large amount of root material

is thus deposited in the land at the very surface. The soil is thus left in excellent physical condition and as the roots decay they supply a large amount of humus particularly rich in fertilizing elements. In one year the Department of Field Huebandry spent some time in removing the alfalfa roots from the land to a depth of two feet. This was divided into four layers of six inches each and the roots were carefully separated from each layer. The roots from each of these depths were then analyzed by the Chemical Department of the College. The percentages of the fertilizing constituents in the dried roots of seventeen months' old alfalfa for each of the four six-inch layers were as follows:

Roots taken from different depths of Soil	Nitrogen N.	Potash K ₂ O	Phosphoric Acid P ₂ O ₅	Lime Ca O
First six inches.....	1.64	.66	.55	.59
Second six inches	1.58	.41	.56	.38
Third six inches	1.59	.43	.51	.48
Fourth six inches	1.58	.42	.48	.75

The roots of young alfalfa plants were found to contain larger percentages of fertilizing materials than those of the plants which were seventeen months old.

USES OF ALFALFA.

In the Province of Ontario alfalfa may be used in a variety of ways, such as for the production of hay, green fodder, pasture, seed, green manure, silage or as a cover crop in orchards. Possibly its use in this Province is in about the same order as here given.

For the production of hay it is a most valuable crop. Under favorable conditions it produces large yields of hay of excellent quality. Very great care, however, should be taken to cut the alfalfa at the commencement of bloom or at the beginning of the second growth of stems at the crowns of the roots. Extensive experiments at the College show that alfalfa deteriorates very rapidly both in percentage composition and in digestibility after the early blossoming stage. Caution should also be exercised not to allow the alfalfa to lie very long in hot dry sunshine as the leaves soon become crisp and are easily broken from the plants. As analyses show the leaves to be the richest part of the alfalfa, special care should be exercised to lose as few of them as possible. For the best quality of hay it is considered wise to rake the alfalfa into windrows as soon as it is sufficiently wilted and, at the proper time, to place the material in cocks where the curing process should be finished.

The green fodder produced by alfalfa is both nourishing and appetizing. It is often an advantage to start to cut alfalfa for green fodder some time before it has started to bloom. That portion of the crop which cannot be used for this purpose before one-third of the blossoms have made their appearance should be cut and cured into hay. The fact that alfalfa is a perennial plant, and the fact that it produces two, three and four cuttings in the one season, makes it a very desirable crop to use for the production of green fodder for feeding to farm stock to supplement pastures in the dry hot summers.

In the average results of experiments conducted at the College in four different years, alfalfa, when grown alone, gave a greater yield of pasture per acre than any one of the following crops: Common Red Clover, Mammoth Clover, Alsike Clover, White Clover, Yellow Trefoil, Sainfoin and Burnet. When grown and pastured alone, however, there seems to be even a greater risk of cattle and sheep becoming bloated than when pasturing on clover. The writer has never heard of injurious results from bloating with any kind of farm stock pasturing on alfalfa, providing it is used in combination with grasses and clovers in the form of a permanent pasture. In pasturing alfalfa there is a danger of either cattle or sheep eating the tops so closely to the ground that they are apt to injure the crowns of the roots and in some cases to entirely kill the plants. Some excellent results have been obtained from pasturing hogs and poultry on alfalfa.

In each of eight or ten years seed has been produced at the College from either the first or the second cuttings of alfalfa. The results have been about the same from each cutting when sown broadcast, but have been largest from the first cutting when the alfalfa has been sown in rows. The production of alfalfa seed has been only fairly satisfactory at the College but in some parts of Ontario it is becoming an important industry. Further information is given in this bulletin under the heading of "Alfalfa Seed Production."

Alfalfa is not used alone as a silo crop to any great extent in the Province. The fact of its producing three crops in the season, two of which come at inopportune times for filling the silo, forms one of the objections to using the crop for silage purposes. The third crop of the season, which is usually ready for cutting about the middle of September, is sometimes placed in the silo along with corn to excellent advantage. When alfalfa is used alone for silage it is difficult to cure and is apt to produce a dark colored silage as is the case with nearly all of the legumes.

Alfalfa certainly produces a large amount of exceedingly valuable material which can be used as a green manure. In the majority of cases, however, it is probably better to use the crop for feeding purposes and then to save the manure and return it to the land in that form rather than to plow under the whole crop.

It is quite probable there are other crops more suitable for using as a cover crop in orchards than alfalfa. The growth of the plants is upright and rather open, and the roots penetrate so deeply into the soil that they tend to rob the subsoil of its fertility and of its moisture, both of which are so essential to the best welfare of the trees.

ALFALFA IN COMBINATION WITH CLOVERS AND GRASSES FOR PASTURE PRODUCTION.

While it is not generally recommended, except in special circumstances, to pasture alfalfa when grown alone, this crop can often be used in combination with grasses and clovers for permanent pastures. For this purpose either one of the following mixtures of varieties and quantities of seed per acre should give good satisfaction: Mixture No. 1—Alfalfa, 4 pounds; White or Dutch Clover, 1 pound; Timothy, 4 pounds; Orchard Grass, 8 pounds; and Meadow Fescue, 8 pounds, making a total of 25 pounds of seed per acre. Mixture No. 2—Alfalfa, 6 pounds; Alsike Clover, 2 pounds; White or Dutch Clover, 1 pound; Orchard Grass, 4 pounds; Meadow Fescue, 4 pounds; Tall Oat Grass, 3 pounds; Meadow Foxtail, 2 pounds; and Timothy, 2 pounds, making a total of 24 pounds of seed per acre.

The last named mixture has been carefully tested at the College and has given good results over a long period of time.

The seed of a permanent pasture mixture can be sown in the early spring, either with or without a grain crop. It is better to select some cultivated crop which has been carefully looked after during the previous season. If the seed mixture is sown alone, the tops of the plants should be cut occasionally during the summer and allowed to lie on the ground as a mulch. If a nurse crop is used, about one bushel of barley or of spring wheat per acre is recommended. As a rule, oats do not form a good nurse crop for a permanent pasture mixture. If, however, they are used they should be sown thinly. The seed for the permanent pasture should be sown in front and not behind the tube drill. Some of the finer seeds can be sown from the grass seed box and the others by hand.

The most desirable combination of hardy grasses and clovers, when once well established on suitable land, should produce a good pasture, appetizing to the animals, excellent in quality, abundant in growth and permanent in character.

ALFALFA IN COMBINATION WITH CLOVERS AND GRASSES FOR HAY PRODUCTION.

Sixteen mixtures of grasses and clovers for hay production have been grown in each of six separate two-years' tests. Alfalfa, Common Red Clover, Mammoth Red Clover and Alsike Clover were used in combination with Timothy, Orchard Grass, Tall Oat Grass and Tall Fescue Grass. Each mixture consisted of a grass and a legume. The mixtures produced either two or three cuttings each season. The third cutting resulted from the mixture containing alfalfa. The seed mixtures were sown with a grain crop in every case. No crop was obtained in the same year in which the seed was sown. The cuttings were made in every instance from the second and the third years after seeding took place. The following table gives the annual average yield of green crop and of hay per acre per annum for the six separate tests of the four mixtures containing alfalfa, and also for the mixture of Timothy and Common Red Clover:

Mixtures	Green Crop	Hay Crop
	Tons	Tons
Tall Oat Grass and Alfalfa.....	18.17	5.20
Orchard Grass and Alfalfa.....	18.56	4.85
Timothy and Alfalfa.....	17.24	4.64
Tall Fescue Grass and Alfalfa.....	18.81	4.57
Timothy and Common Red Clover.....	12.02	3.40

Of the sixteen different mixtures the four containing alfalfa surpassed all others in yield of green fodder and in yield of hay per acre. It will be noted that the annual yield of the Tall Oat Grass and Alfalfa was 1.8 tons greater than that of the Timothy and Common Red Clover. In this experiment the Alfalfa of the legumes and the Tall Oat of the grasses exerted the greatest influence in producing a high yield of hay and the Timothy and the Alsike Clover the greatest influence in low hay production. The Alfalfa and the Tall Oat Grass are both very hardy, start early in the spring, are ready to cut at about the same time, withstand hot dry weather in the summer and form a good growth in the autumn.

IMPORTANT SUGGESTIONS FOR THE SUCCESSFUL PRODUCTION OF ALFALFA.

Select land having a clean, mellow, fertile surface soil, preferably of a calcareous nature and overlying either a naturally or an artificially well drained subsoil. If the soil is acid, lime should be applied. Use large plump seed of strong germinating power and of some hardy variety such as Grimm or Ontario Variegated. The Common alfalfa seed of the Western States, even though it has been northern grown, usually produces plants which are too tender to long resist the climatic conditions of Ontario. Make use of seed which grades high according to the Seed Control Act. Inoculate seed with the proper kind of bacteria, providing alfalfa has not been grown successfully on the land in recent years. Sow the alfalfa seed at the rate of eighteen or twenty pounds per acre. Any one of the following methods has proven decidedly successful according to the results of experimental work:



Two rows of Grimm Alfalfa, which show decided hardiness in comparison with those on either side, which are tender varieties and unsuited for cultivation in Ontario.

1. If the land is free from weed impurities alfalfa seed may be sown on winter wheat in the early spring either on the old snow or, better still, on a fresh snow of one or two inches. When sown in this way no harrowing or cultivation is necessary.

2. On a suitable seed bed, and as soon as the land is sufficiently dried in the spring, alfalfa seed may be sown from the grass seed box placed in front of the tube drill. About one bushel of barley, wheat or rye per acre sown from the tubes of the drill makes a very good nurse crop. Oats are not quite as suitable as they are somewhat more smothering and require a long season for maturity. After the alfalfa seed is sown the land should be harrowed lightly.

3. About the middle of July alfalfa seed may be sown alone on land which has been carefully summer fallowed providing there is sufficient moisture for good germination.

Alfalfa should never be pastured during the first year and seldom, if ever, afterwards, as the pasturing very frequently destroys the plants. The crop should be cut for hay or for green fodder in the following year after the seeding takes place and as soon as the plants start to bloom. Care should be taken to protect

the crop from rain and to retain as many of the leaves as possible. In many places in Ontario alfalfa will produce three crops of hay per annum. The third cutting, however, may be used to advantage for mixing with corn when filling the silo as this forms an easy method of handling the green alfalfa in the autumn and also improves the quality of the corn silage. In favorable seasons, and especially in some localities, hay may be obtained from the first crop and seed from the second crop in each season and for a period of several years.

If the directions here given are carefully followed alfalfa may be expected to produce large and valuable crops for a number of years without re-seeding.



A few Alfalfa plots, showing the Ontario Variegated in the front, the Grimm farthest away, and the Common Alfalfa from the Western States in the centre. The reader will observe how tender the alfalfa obtained from Colorado, Utah, Nebraska and Texas is in comparison with the other two hardy varieties.